Pediatrics & Therapeutics
ISSN: 2161-0665

Ebrí, et al., Pediat Therapeut 2015, 5:1
DOI: 10.4172/2161-0665.1000227

Short Communication Open Access

Studies in Spanish Children to Calculate Bone Age and Predict Adult Height: Forty Years of Own Investigation

Bernardo Ebrí Torne* **and Inmaculada Ebrí Verde**

Department of Pediatrics, Hospital Universitary Miguel Servet, Spain

***Corresponding author:** Bernardo Ebrí Torne, Associate Professor, Department of Pediatrics, Hospital Universitary Miguel Servet, Viñedo Viejo 2 escalera 13-1, Zaragoza, 50009, Spain, Tel: 34976566695; E-mail: ebri@ebri.es

Rec date: Nov 20, 2014, **Acc date:** Dec 22, 2014, **Pub date:** Dec 24, 2014

Abstract

Introduction: The authors make a historical review of his research over 40 years dedicated to the study of bone maturation in 5225 healthy children Spanish and Swiss. Bone ages are obtained using their own methodology and it lets you know whether the bone age of the child is normal, early or delayed, significantly or not. Numerical formulas are obtained from measurements of the carpal bones, metacarpals, phalanges and tarsal region, by radiographs of the left hand and foot. Lately, the authors have applied their methodology to all annual radiological cuts made since the child's birth through 20 years of 160 Spanish children.

Materials & methods: The longitudinal case series studied includes 160 Aragon healthy children of both genders (Andrea Prader Center), aged between six months and 20 years old, and studied year after year. We obtained measurements (maximum diameters in mm) of each bone carpal and metacarpal and phalanges of the fingers I, III and V of the left hand. The radiological study has been conducted at Miguel Servet Hospital in Zaragoza. For the statistic work we have used the "Statistix" statistics Packaged, as well as Excel program for the confection of the equation tables.

Results: In this study we applied in our children, indexes: Ebrí metacarpalfalangeal, carpal and carpometacarpalfalangeal Ebrí and called IVO (Index Valuation Ossification) derived of each respective index, serving for very accurate estimate of bone age. The results can bring to a Gaussian shape equivalences, which gives us directly bone age of the child, and if it is late or early or not significant.

Conclusions: The use by the pediatrician and researcher of Ebrí equations for calculating bone age, allow very accurately assess bone maturation from one child to study. With the use of the software we offer, the results are obtained directly, without being required to pocket calculator. With the software, predicting adult height of children is also obtained. With our methodology we can dispense the use of American method of Greulich and Pyle, and English Tanner Whitehouse, at least in children of Hispanic origin. The gold standard of our contribution is that this basic methodology can be applied to different populations in order to create international standards series. Comparative studies between them can be made by the researchers. The possibilities in this regard are many.

Keywords: Ebrí bone ages carpal; Metacarpal; Carpometacarpal; Predictions of adult height Ebrí; Longitudinal and transversal series of Spanish healthy children

Introduction

Bone maturation is the best overall indicator of biological development we have in the human species. Bone age expresses this maturation process, requiring simple radiological studies for determining, with the left hand radiograph in the opinion of most authors, the preferred anatomical region [1].

To calculate bone age, morphological and numerical methods may be used. Our numerical methods have an advantage over morphological because they have greater accuracy, eliminating asynchrony and the subjectivity of the doctor when he chooses the model radiography in the Atlas of Greulich and Pyle [2].

Our original method of studying bone age in the carpus and the tarsus in a large cross number of children has been referenced extensively in the literature. A Spanish population of 5225 healthy children was studied by the method IVO carpal and 540 by the method IVO tarsal. 96 fetuses of both sexes in tarsal region were also studied. This research was published over several years [3-16]

Recently we have studied a longitudinal series of Spanish children to calculate bone age of these children and predict adult height [17-19]. The casuistry of this study comes from the General Survey Anthropometric Aragonés "Andrea Prader Somatometric and Radiological Study" [20] promoted by the Endocrinology Unit of Miguel Servet Hospital of Zaragoza. It was authorized by the Research Committee and officially endorsed by the "Direction General of Aragon" in Spain. The 1956 Graffar [21] poll was used for the social economical classification of children.

Material and Methods

The authors have applied their methodology to all annual radiological cuts made since the child's birth through 20 years of Spanish children. The total sample of the study has been 160 healthy children (73 male y 87 female). These children were radiographed in

his left hand on his birthday at Miguel Servet Hospital in Zaragoza (Spain).

In each radiograph of left hand we measured the epiphysis cores of the metacarpal and phalanxes, and the carpals bones, including those of the radius and ulna bones. The maximum core distances were measured with a nonius that optimally expresses the measurements done, which have been the basis to elaborate the IMF (metacarpalfalangeal index) ICMF (carpometacarpalfalangeal index) and IC (Carpal index) These indexes are expressed in millimeters (mm), and its result is the sum of the maximum diameters of the carpal bones, epiphysis cores of the metacarpal and phalanxes bones: I, III, y V, as well as the ulna and radius distal epiphysis, with a total of 21 cores for ICMF index; 13 for IMF index; and 11 for IC index. Figures 1 and 2 show the maximum distances of the ossifying cores to be measured. Once the sum of the existing cores at the moment of radiography measurement is obtained, it is divided by 13 (IMF index), by 11 (IC index) and for 21 (ICMF index) for index numerical simplification purposes (a fixed number in all cases, although at the time of measurement not all cores were available).

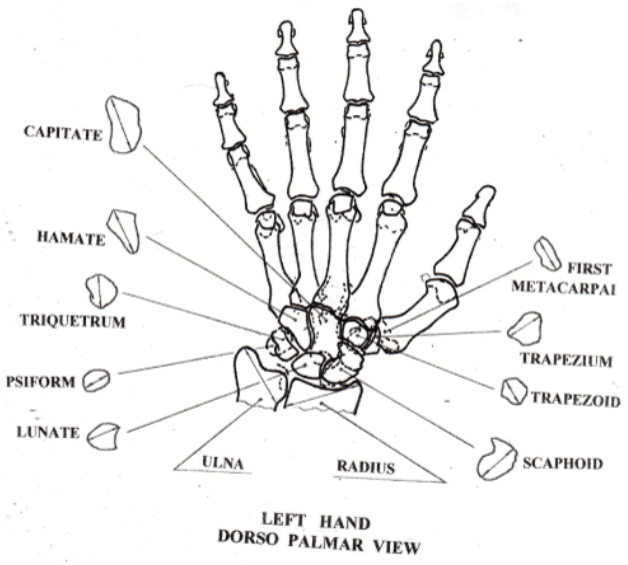

Figure 1: Carpal bones.

All radiography measurements were done by a single observatory, and the repetition study conducted in 100 radiographies one month after the first measurement, was above 95%.

For the statistical task we used the "Statistix" statistical software Packaged, version 9, year 2000.

Co-relation ratios of the variables (IMF, IC and ICMF and chronological age) were performed in order to obtain the equation of the regression line, and to obtain the child's bone age prediction from it. In order to optimize the reading of the bone age of the studied child, and its graphic expression on a Gauss graphic, we obtained the so-called IVO (Ossification index Valuation). The IVOS indexes derived of each index: (Index IVOMF of index IMF, IVOIC of index IC, IVOICMF of ICMF index) allow obtaining the bone age of the child for each index. To this end, followed by the same general method Ebrí Torne used in various publications and now we abbreviate in honor shortly [17-19]. Consequently, having each index: IC, IMF, ICMF result of the summation of the carpal bones and metacarpalfalangeal, and chronological age in days, IVOS are obtained. Being taken to a Bell Gaus (Figure 3) we can read in it the diagnosis of bone age of the child.

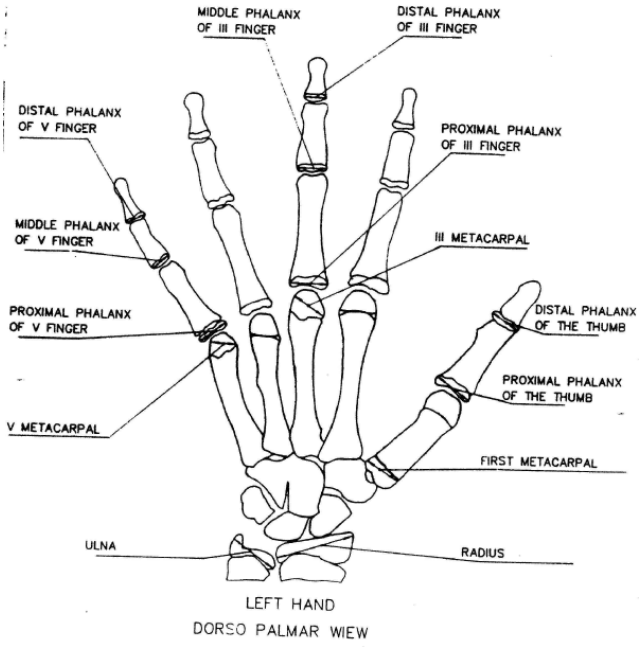

Figure 2: Metacarpalfalangeal, bones.

Equations:

Males

IVOIC = 62.3 + 13.2 x IC – 0.05 x CA

IVOIMF = 41.3 + 17.8 x IMF – 0.04 x CA

IVOICMF = 49.4 + 17.5 x ICMF – 0.05 x CA

Female

IVOIC = 41.7 + 12.2 x IC – 0.04 x CA

IVOIMF = 24.8 + 15.5 x IMF – 0.03 x CA

IVOICMF = 30 + 15.2 x ICMF – 0.04 x CA

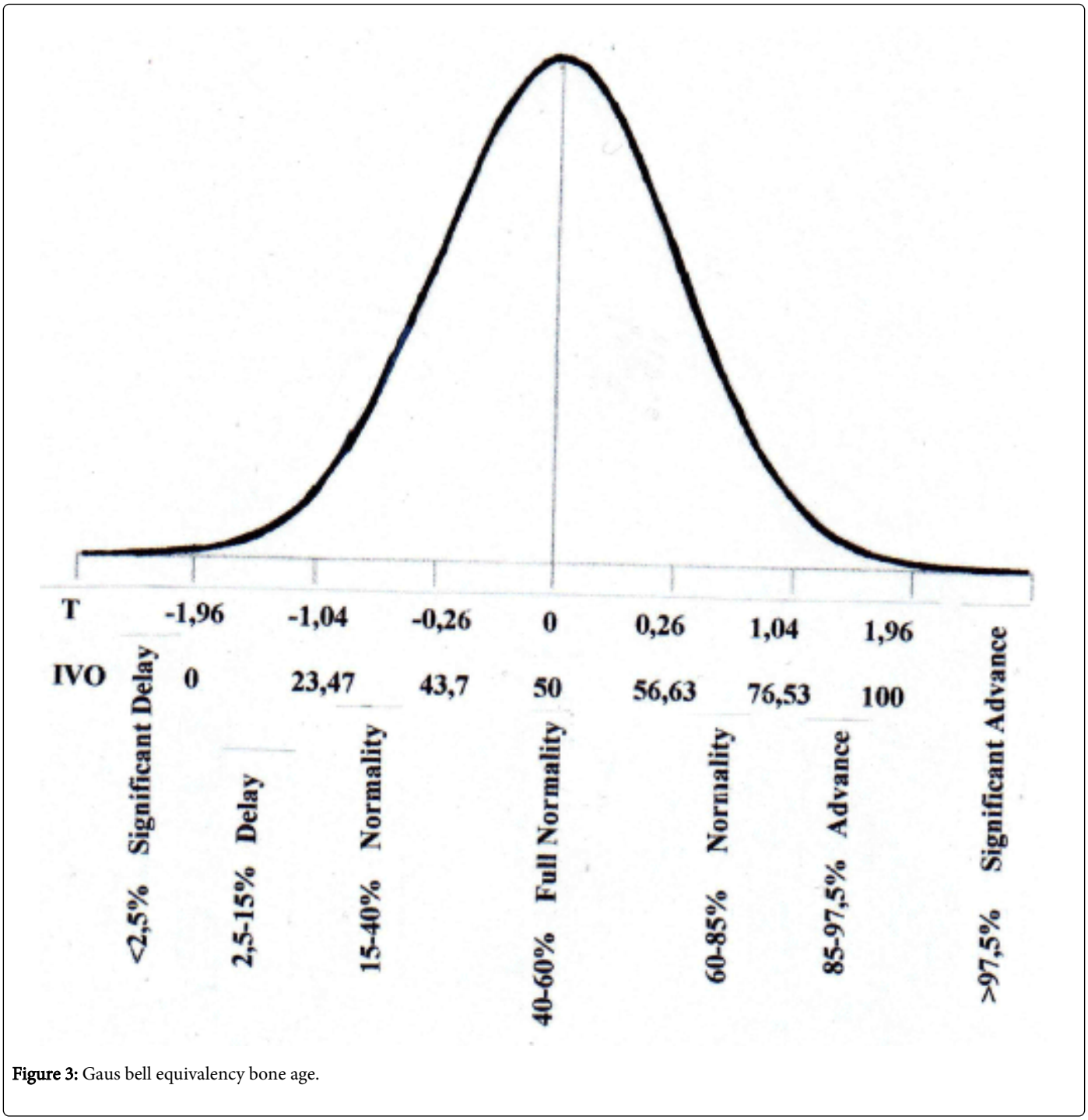

Figure 3: Gaus bell equivalency bone age.

Results

We offer the equations for the IVOS derived of each index in children of both sexes. The chronological age (CA) is expressed in days and the various indexes: IC, IMF, and ICMF in mm.

To simplify the work of practical, we performed a computer program, so that introducing the measures of each bone radiography, date of birth of the child, their size and their parents, the program gives directly his bone age and also predicting adult height. It has a manual easy to use. We expose as an example, the case of a twelve and a half years with a delay in bone age, and his prediction of adult height (Figure 4). The software will be required to authors via email. They will send the software for free also by email.

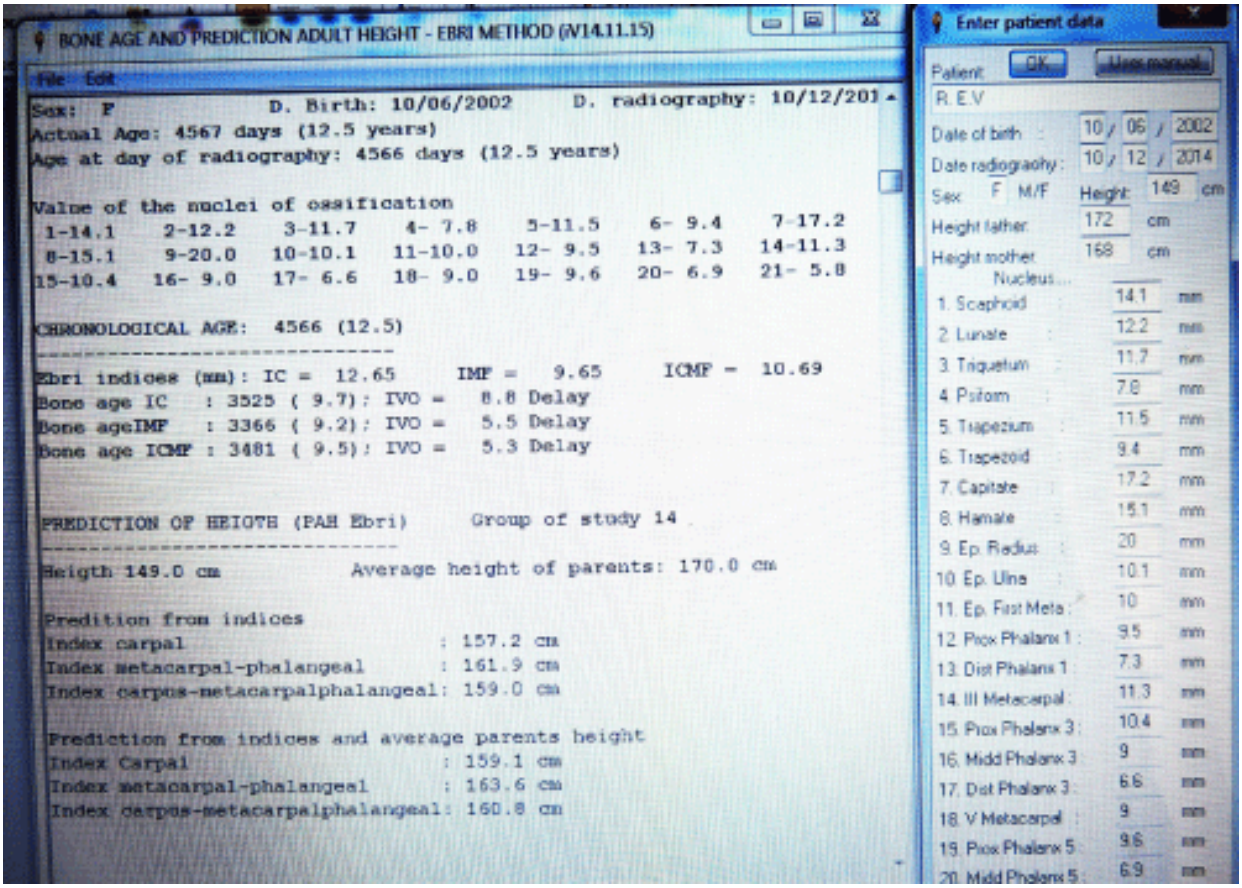

Figure 4: Computer window: Studied example of a child.

Discussion

The authors had conducted a longitudinal study in Swiss child [22-23], however there was a gap in own longitudinal studies regarding the calculation of bone age and predicted adult height, in Spanish-speaking countries and Anglo. We adjust our methodology to the Swiss population (36 healthy children between 10 and 19 years in the case of males, and 10 and 18 years in the case of females were studied) and this population was compared with the Spanish population [24]. In this study we applied in our children, indexes: Ebrí metacarpalfalangeal, carpal and carpometacarpalfalangeal Ebrí and called IVOS derived of each respective index. With our methodology we can dispense the use of American method of Greulich and Pyle, and English Tanner Whitehouse, at least in children of Hispanic origin, since these methods distortive calculate bone age when applied to populations they are not Anglo-Saxons. Comparisons between our method and the Greulich-Pyle [2] and Tanner [25] were made, demonstrating its validity. We have studied equivalence between our method and commented [26-29].

This methodology can be applied by the pediatrician in their daily practice, in order to diagnose normal, early or delayed bone age and predicted adult height of children. Although numerical calculations can be obtained with a pocket calculator, to simplify this process, we have also created a computer program that automatically provides a simple way to obtain data, when introduced into the measurements of each bone and the size of the child and parents. This program and instructions for its use are available to the researcher or pediatrician request. In addition, and given the original universal formula "aseptic" to achieve our indexes of ossification, this formula can be grafted or applied to indigenous populations, so as to have bone ages of children in each country studied. Thus, one way to create theses is open, in order to create standards of Hispanic, Anglo, African and Asian populations. Comparative studies between them can be made by the researchers. The gold standard of our contribution is that this basic methodology can be applied to different populations. The possibilities in this regard are many.

Conclusions

The use by the pediatrician and researcher of Ebrí equations for calculating bone age, allow very accurately assess bone maturation from one child to study. With the use of the software we offer, the results are obtained directly, without being required to pocket calculator. With the software, predicting adult height of children is also obtained. . With our methodology we can dispense the use of American method of Greulich and Pyle, and English Tanner Whitehouse, at least in children of Hispanic origin. The gold standard of our contribution is that this basic methodology can be applied to different populations in order to create international standards series. Comparative studies between them can be made by the researchers. The possibilities in this regard are many.

References

1. Martí Henneberg C, Roy MP, Passe NP (1975) El análisis de la maduración esquelética en el hombre. Metodología. Med Clin 2: 49.
2. Greulich W, Walter W, Pyle SI (1959) Radiographic Atlas of Skeletal Development of the Hand and Wrist. Second Edition. Stanford University Press.
3. Ebrí Torné B (1977) Contribución al estudio de la osificación del Tarso. Estudio de la edad ósea desde el nacimiento hasta los 16 años, siguiendo metodología numérica, basada en un índice obtenido en el tarso, denominado Indice Tarsiano". Revista del Seminario de la Cátedra de Patología Médica A de Barcelona. Archivos Españoles de Medicina Interna; 10: 721-724.
4. Ebrí Torné B (1978) Estudio numérico y radiológico de los huesos del Tarso, en una población humana desde la época fetal hasta la pubertad. Actas del X Congreso de la S. A. E, Zaragoza 175-181.
5. Ebrí Torné B (1979) Estudio estadístico y ritmo de osificación de los huesos tarsianos en el niño. RIMT: 6: 128-138.
6. Ebrí Torné B (1979) Presentación de un nuevo método biométrico (I. V. O.) para la valoración de la edad ósea en niños. Medizinische Klink 214: 50-56.
7. Sobradillo B (1979) Predicción de la talla adulta. Monografía sobre Nutrición, crecimiento y desarrollo. Instituto de Investigación sobre Crecimiento y Desarrollo. Fundación Faustino Orbegozo. Bilbao 55-63.
8. Ebrí Torné B (1979) Maduración ósea. Análisis secuencial cronológico y diferencial de los núcleos de osificación del Tarso, procedente de la población de la Maternidad Provincial de Zaragoza. Munchener Medizinische Wochenschrift 3: 129-139.
9. Ebrí Torné B (1988) Maduración ósea sobre Tarso y Carpo (Estudio Clínico-Radiológico Infantil) Editorial Heraldo de Aragón. Zaragoza, Septiembre.
10. Ebrí Torné B (1988) Atlas Radiográfico de Carpo y Tarso. Editorial Heraldo de Aragón. Zaragoza, Septiembre.
11. Ebrí Torné B (1988-89) Estudio de población española de 5225 niños y 540 de ambos sexos por el método conjunto del Carpo (IVOC) y del Tarso (IVOT) en programa Basic. Adaptación de la edad ósea Ebrí a la edad ósea de Greulich-Pyle y de Tanner- Whitehouse para la predicción de talla". Discurso en la Real Academia de Medicina de Zaragoza. Vol LII de conferencias y comunicaciones de la Real Academia de Medicina de Zaragoza. Curso 9-31.
12. Ebrí Torné B (1990) Biometric method adaptation to basic. Acta Paediatr Scand 79: 1242-1243.
13. Ebrí Torné B (1992) Nuevas Ecuaciones para el cálculo de la Edad Ósea en el Tarso por el Método Ebrí tarsiano, en niños recién nacidos hasta los dos y cuatro años. III Congreso Aragonés de Medicina. Real Academia de Medicina. Tomo I. Zaragoza 170.
14. Ebri Torne B (1993) Biometric method for the ossification evaluation of children from birth up to the ages of two and four--applied to the tarsus. Acta Paediatr 82: 872.
15. Ebri Torné B (1993) [New method for evaluating ossification of the carpal bone. From a study with 5225 Spanish children]. Pediatrie 48: 813-817.
16. Ebrí Torné B (1994) Nuevas Ecuaciones para el cálculo de la Edad Ósea en el Carpo por el Método Ebrí carpiano, en niños recién nacidos hasta los dos y cuatro años. Acta Pediátrica Española 52: 79-82.
17. Ebrí Torné B, Ebrí Verde I (2012) [Metacarpophalangeal and carpal numeric indices to calculate bone age and predict adult size]. An Pediatr (Barc) 76: 199-213.
18. Ebrí Torné B, Ebrí Verde I (2012) Nuevo índice de valoración ósea EbríCarpo-metacarpofalángico y de predicción de talla adulta. Pediatr Integral XVI: 822.e1-822.e9
19. Ebrí Torné B, Ebrí Verde I (2013) Biometric Method for the Ossification Evaluation of Children from Birth Up to the Ages of Two and Four - Applied to the Metacarpal and Phalanxes in Spanish Longitudinal Series. Cureus 5: e151.
20. Ferrández Longás A, Baguer L (2005) Estudio longitudinal de niños españoles normales desde el nacimiento hasta la edad adulta. Datos antropométricos, puberales, radiológicos e intelectuales. Zaragoza Fundación Andrea Prader.
21. Graffar M (1956) A method of social qualifying samples of population. Courier C.I.E 6: 445-449.
22. Ebrí Torné B (1992) Determinación de la Edad Ósea por un Nuevo Método Numérico: IC (Índice Carpal) en Población Longitudinal Suiza. XVIII Congreso Extraordinario de la Alape. Sevilla. Anales Españoles de Pediatría 169.
23. Ebrí Torné B (1993) Exposición por percentiles del Índice Carpiano y Talla de Población Suiza procedente del Estudio Longitudinal de Zurich. Comparación con Niño Español. Acta Pediátrica Española 51: 589-593.
24. Ebrí Torné B (1997) Predicción de Talla adulta en niño suizo a través de la metódica predictiva Ebrí incorporada a las edades óseas. Acta Pediatrica Española 55: 330-333.
25. Tanner JM, Whitehouse R H, Healy M J R, Goldstein H (1972) A revised system For estimating skeletal maturity from hand and wrist radiograps with separate standards for carpals and other bones (Tw2 system). Standards for skeletal age. Paris: International Children´s Centre.
26. Ebrí Torné B (1996) Indice de valoración Ósea Metacarpofalángico. Estudio Longitudinal de niño Suizo. Estudio comparado con Tanner II Rus. Acta Pediátrica Española 54: 94-102.
27. Ebrí Torné B (1994) Estudio estadístico y descriptivo en niño suizo de la edad ósea en el carpo por los métodos de Tanner y Ebrí. Revista Española de Cirugía de la Mano 21: 67-75.
28. Ebrí Torné B (1997) Estudio comparativo de las edades óseas Tanner-Rus, Tanner Carpal- Ebrí Carpal, Ebrí Metacarpofalángica, y Greulich y Pyle. Acta Pediátrica Española 55: 369-374.
29. Ebrí Torné B, Ebrí Verde I (2012) Estudio comparativo entre las edades óseas Greulich-Pyle, Tanner-W2 y Ebrí y entre predicciones de talla adulta. Pediatr Integral XVI: 741. e1-741.e7.